AEC-NASA TECH BRIEF

Study of Mechanical Properties of Uranium Compounds

A study was initiated to determine the mechanical properties, including brittleness and ductility of several uranium compounds. These include uranium dioxide (UO_2), uranium sulfide (US), and uranium phosphide (UP).

It was found that UO_2 has a brittle-ductile transition between 1250° and 1500°C. Up to 1250°C, imposed strain caused a high modulus of rupture, but above this temperature maximum deflections increased. At 1750°C, the rate of maximum stress to deflection was approximately constant, regardless of the strain rate, indicating an optimum plasticity for relaxation.

US was tested with both UOS and UO_2 as impurities. The brittle-ductile transition occurred at approximately 1000°C for the UOS-bearing compound, and at around 1250°C for that containing UO_2.

UP containing 1% UO_2 was found to have a transition temperature at approximately 1250°C.

UO_2 remained stronger than the other compounds tested at all temperatures except 1000°C, but was less plastic. US containing UOS was consistently the weakest material. The temperature dependence of stress was similar in all the materials between 1250° and 1750°C.

Bars of UO_2 were cold-pressed in a hardened steel die from high purity depleted UO_2 powder. A Carbowax binder (dissolved in hot water) was used during pressing and removed afterwards. Bars of US were formed in the same die used for the UO_2 using US powder which was crushed, sieved to 100 mesh, and finally ball-milled. A binder of 1% stearic acid was used and the powder was sintered at between 1800° and 1850°C. A similar process was used in producing UP bars.

Load-deflection tests were conducted at room temperature, 1000°, 1250°, 1500°, 1750°, and 1900°C in atmospheres consisting of air, helium, and hydrogen, as well as in a vacuum. The testing machine used for the tests was fitted with controlled straining gear. Three load rates (slow, medium, and fast) were used, and rate of loading and strain rate were measured and recorded.

Complete details of this study are contained in: *Mechanical Properties of Uranium Compounds*, by C. R. Tottle, ANL-7070, Argonne National Laboratory, Argonne, Illinois, November 1965. Copies of this report are available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price: $3.00 microfiche $0.65.

Notes:

1. One binary system consisting of 62% UO_2 and 38% UP, was tested and was found to have less strength but greater plasticity than either of its constituents.
2. Additional details may be found in *High Temperature Mechanical Properties of Uranium Compounds*, by R. J. Beals, J. H. Handwerk, and G. M. Dragel, September 14, 1967. This article was prepared for presentation and publication in *Proceedings of the Third International Symposium on High Temperature Technology*, Asilomar, California, on September 17-20, 1967 (in press).
3. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B68-10197

Source: C. R. Tottle, R. J. Beals, J. H. Handwerk, and G. M. Dragel, Metallurgy Division (ARG-10074)

(continued overleaf)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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